Developmental and Cognitive Outcomes in Children with Cleft Lip and Palate

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Abstract

Background: Cleft lip and palate are the most common congenital craniofacial anomalies worldwide. Beyond cosmetic and functional challenges, affected children may be at increased risk of neurodevelopmental delay and intellectual impairment. Data from Indian populations remain limited.

Methods: This cross-sectional study included 120 children aged 6 months to 12 years with cleft lip, cleft palate, or both, attending a tertiary care center in Nagpur. Developmental assessment was performed using the Bayley Scales of Infant and Toddler Development (Bayley-III), Denver Developmental Screening Test II (DDST-II), and Wechsler Intelligence Scale for Children (WISC-IV), depending on age. Clinical data, socioeconomic background, and hearing status were documented. Statistical analysis was performed using Chi-square and Fisher's exact tests.

Results: Developmental delay or intellectual impairment was observed in 39 children (32.5%). Prevalence was significantly higher in children with cleft palate (isolated 40.7%, combined 44.4%) compared to cleft lip alone (18.7%) ($p = 0.01$). Speech and language delay (66.7%) was the most common domain, followed by cognitive delay (28.2%) and motor delay (15.4%). Hearing impairment was detected in 25.8% of children and was significantly associated with developmental delay (54.8% vs. 24.1%, $p < 0.05$). Syndromic clefts (66.6%) and lower socioeconomic status (38.7%) were also linked to higher rates of delay.

Conclusions: Nearly one-third of children with cleft lip and/or palate exhibit developmental delay, with higher risk in those with cleft palate, hearing loss, syndromic features, and socioeconomic disadvantage. Early multidisciplinary intervention including screening, speech therapy and surveillance is necessary to optimise long-term outcomes.

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Introduction

Cleft lip and palate represent the most common congenital craniofacial anomalies worldwide, with a prevalence estimated between 1 in 700 and 1 in 1,000 live births.[1] These anomalies occur due to disruptions in embryological development of the maxillofacial structures, often presenting as isolated defects or as part of a broader syndromic condition.[2] While surgical correction addresses the cosmetic and functional aspects of clefting, emerging evidence suggests that affected children may also be at risk for neurodevelopmental challenges.[3]

Neurodevelopmental outcomes in children with cleft lip and palate are complex and multifactorial.[4] Speech and language delays are well documented, primarily due to velopharyngeal insufficiency, recurrent otitis media, and associated hearing loss.[5] Beyond these expected difficulties, several studies have reported higher rates of cognitive delay, attention deficits, and academic underachievement, particularly in children with cleft palate only or syndromic clefts.[6] Structural brain differences observed in neuroimaging studies further support a possible shared developmental pathway between craniofacial formation and central nervous system development.[7]

Early identification of developmental delay is crucial, as timely intervention with speech therapy, educational support, and multidisciplinary care can significantly improve long-term outcomes.[8] However, data from many regions remain limited, and the relationship between cleft subtype, socioeconomic factors, and developmental outcomes is not fully understood.[9]

Therefore, the present study is designed to assess the prevalence of developmental delay and intellectual impairment in children with cleft lip and/or palate, and to explore the associations between developmental outcomes and clinical, demographic, and environmental factors.

Materials and Methods

Study Design and Setting

After an ethical approval this was a cross-sectional observational study conducted at the Department of Pediatrics in a tertiary institution. The study was carried out over a period of 6 months.

Study Population

Children diagnosed with cleft lip, cleft palate, or both, who attended the outpatient and inpatient services during the study period, were recruited.

Inclusion Criteria

- Children aged 6 months to 12 years with cleft lip, cleft palate, or both
- Both syndromic and non-syndromic cases
- Parents/guardians who provided informed consent

Exclusion Criteria

- Children with major unrelated congenital anomalies (e.g., neural tube defects, congenital heart disease)

- Children with diagnosed neurological disorders independent of cleft etiology (e.g., cerebral palsy, epilepsy)
- History of severe perinatal hypoxia, birth asphyxia, or extreme prematurity (<32 weeks gestation)
- Lack of parental consent

Sample Size
A total of 120 children with cleft lip and/or palate were enrolled. Of these, 48 (40%) had cleft lip only, 54 (45%) had cleft palate only, and 18 (15%) had combined cleft lip and palate. The mean age of participants was 5.6 ± 2.8 years, with a male-to-female ratio of 1.3:1.

Assessment Tools and Procedure
Neurodevelopmental assessment was performed using:
- Bayley Scales of Infant and Toddler Development (Bayley-III) for children aged 6 months to 3 years
- Denver Developmental Screening Test II (DDST-II) for children aged 3 to 6 years
- Wechsler Intelligence Scale for Children (WISC-IV) for children above 6 years

In addition, detailed clinical histories were obtained, including socioeconomic status, family history of clefting, speech therapy or surgical interventions, and history of recurrent otitis media. Hearing assessments were performed using pure tone audiometry or otoacoustic emission tests, as age-appropriate.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using SPSS version 26. Descriptive statistics (means, standard deviations, percentages) were calculated. Associations between developmental delay and cleft subtype, age, gender, socioeconomic status, and hearing status were assessed using Chi-square test or Fisher's exact test, with a p-value <0.05 considered statistically significant.

Results
A total of 120 children with cleft lip and/or palate were included in the study. The mean age was 5.6 ± 2.8 years, ranging from 6 months to 12 years. Males accounted for 68 (56.7%) and females for 52 (43.3%), with a male-to-female ratio of 1.3:1.

Distribution of Cleft Subtypes
- Cleft lip only: 48 (40%)
- Cleft palate only: 54 (45%)
- Combined cleft lip and palate: 18 (15%)

Prevalence of Developmental Delay
Overall, 39 children (32.5%) demonstrated developmental delay or intellectual impairment.

- Cleft lip only: 9 of 48 (18.7%)
- Cleft palate only: 22 of 54 (40.7%)
- Combined cleft lip and palate: 8 of 18 (44.4%)

The prevalence of developmental delay was significantly higher in children with cleft palate (isolated or combined) compared to cleft lip alone (p = 0.01).

Domains of Delay
Among the 39 children with developmental delay:
- Speech and language delay: 26 (66.7%)
- Cognitive delay (below average IQ scores): 11 (28.2%)
- Motor delay: 6 (15.4%)
- Multiple domain involvement was observed in 10 children (25.6%).

Hearing Impairment and Delay
Hearing impairment was identified in 31 children (25.8%), predominantly among those with cleft palate. Developmental delay was more common in children with hearing impairment (54.8%) compared to those with normal hearing (24.1%), showing a statistically significant association (p < 0.05).

Socioeconomic and Clinical Correlates
Children from lower socioeconomic backgrounds demonstrated higher rates of developmental delay (38.7%) compared to middle and higher socioeconomic groups (24.4%).
Syndromic clefts (n = 12) were associated with a markedly higher prevalence of delay (66.6%) compared to non-syndromic cases (28.6%).

Discussion
The present study assessed neurodevelopmental outcomes in children with cleft lip and/or palate, with particular focus on developmental delay and intellectual impairment.[3] The findings demonstrate that approximately one-third (32.5%) of children exhibited some form of developmental delay, with higher prevalence among those with cleft palate, either isolated (40.7%) or combined with cleft lip (44.4%), compared to cleft lip alone (18.7%). This emphasizes that cleft palate carries a greater neurodevelopmental burden, consistent with earlier literature.[10]

Previous studies have highlighted similar associations. Richman et al. reported that children with cleft palate performed lower on measures of verbal intelligence and academic achievement compared to those with cleft lip, attributing the difference to both structural and functional consequences of palatal involvement.[10] In a large population-based study, Collett et al. observed that children with cleft palate were more likely to require special educational support, especially in language-related domains, which parallels the predominance of speech and language delays (66.7%) observed in our cohort.[11]

Hearing impairment, predominantly due to recurrent otitis media with effusion, was present in one-quarter (25.8%) of our study population and showed a significant association with developmental delay.[12] This aligns with the work of Flynn et al., who demonstrated that middle ear disease in children with clefts strongly contributes to delayed speech acquisition and poor school readiness.[13] The data of this study reinforce the importance of early otologic evaluation and intervention in cleft care protocols.[14]

The association between syndromic clefts and neurodevelopmental outcomes was also evident.[3] Two-thirds (66.6%) of syndromic cases in our sample had developmental delay, markedly higher than in non-syndromic clefts (28.6%).[6] This observation supports reports by Conrad et al. and others, who documented that syndromic clefts, particularly those linked to chromosomal abnormalities such as 22q11.2 deletion, are strongly correlated with global developmental delay.[15]

Socioeconomic status emerged as another important determinant.[16] Children from lower socioeconomic backgrounds had a higher prevalence of developmental delay (38.7%) compared to those from middle or higher strata.[17] While genetic and clinical factors are undeniable, environmental influences such as nutrition, access to speech therapy, and parental education may play a significant role.[18] These findings echo a study by Wehby et al., which emphasized the cumulative impact of socioeconomic disadvantage on developmental trajectories in cleft populations.[19]

Our findings also underscore the multifactorial etiology of developmental delay in cleft lip and palate patients, with structural brain differences playing a contributory role.[6] Neuroimaging studies, including those by Conard et al., have identified subtle alterations in cerebellar and cortical structures in children with clefts, which may explain deficits in verbal and executive functioning.[20] This biological link between craniofacial and neural development supports the hypothesis of shared embryological pathways.[21]

Strengths and Limitations

The strength of this study lies in the use of standardized developmental assessment tools across age groups and a well-defined sample stratified by cleft subtype. However, the cross-sectional design limits causal inference, and the relatively small sample size restricts generalizability. Longitudinal follow-up with neuropsychological testing and neuroimaging would provide deeper insights into developmental trajectories.

Implications

The results highlight the need for early, multidisciplinary screening of neurodevelopmental outcomes in children with cleft palate, particularly those with associated hearing loss or syndromic features. Integration of speech therapy, audiological services, and neurodevelopmental assessment into cleft care programs could substantially improve long-term outcomes.

Conclusion

In this study, nearly one-third of children with cleft lip and/or palate demonstrated developmental delay, with a significantly higher prevalence among those with cleft palate, particularly syndromic cases. Speech and language delay emerged as the most frequent domain of impairment, often compounded by hearing loss and socioeconomic disadvantage. These findings highlight that clefting is not merely a structural anomaly but may also be a marker of broader neurodevelopmental vulnerability.

Early identification and targeted intervention, including regular hearing surveillance, speech and language therapy, and neurodevelopmental assessments, are essential components of comprehensive cleft care. By addressing these factors within a multidisciplinary framework, long-term academic, cognitive, and social outcomes for affected children can be substantially improved.

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Availability of Data

Authors declare to supply the data upon requests through the corresponding author.

Conflicts of Interest

Authors declare no conflicts.

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